AD NUMBER
AD041632
CLASSIFICATION CHANGES
TO: **unclassified**
FROM: **confidential**
LIMITATION CHANGES
TO: **Approved for public release; distribution is unlimited.**
FROM: **Distribution authorized to DoD only; Administrative/Operational Use; 13 SEP 1954. Other requests shall be referred to Office of Naval Research, One Liberty Center, Suite 1425, 875 North Randolph Street, Arlington, VA 22203-1995. Pre-dates formal DoD distribution statements. Treat as DoD only.**
AUTHORITY
30 Sep 1966, DoDD 5200.10; ONR ltr dtd 26 Oct 1977

AD _____

ELECTRICAL ENGINEERING RESEARCH LABORATORY

THE UNIVERSITY OF TEXAS

Memorandum No. 13 13 September 1954

NOTES ON THE OPERATIONAL CHARACTERISTICS OF BOMAC MAGNETRON TYPE BL 201 TUBES NOS. 63 and 33

by

C. W. Tolbert

A. W. Straiton

Prepared Under Office of Naval Research Contract Nonr 375(01)

NR 071032

Two Bomac Magnetrons, Type BL 201 have been used for 4.3 millimeter propagation measurements and although they required very careful control in operation, they have been found to be satisfactory for this purpose.

After tube no. 63 was operated for approximately twenty hours, the power level decayed gradually during the operation periods. Since the precision measurements required for the propagation tests required constant power output, the use of this tube was abandoned. This deterioation may have been due to the vibration it received during the frequent movement of the magnetron in the calibration procedures.

Tube 33 was put into use and in 30 hours of satisfactory operation has shown little or no change in operating characteristics.

I. INTRODUCTION

The Electrical Engineering Research Laboratory of The University of Texas has been investigating the propagation of millimeter radio waves for the Office of Naval Research for several years. A series of tests at 8.6 millimeter wavelength were made after the necessary transmitting and receiving equipment had been constructed and assembled.

The tests were recently extended to 4.3 millimeter wavelengths when magnetrons for this wave length became available. Bomac Laboratories of Beverly, Mass. built a number of type BL 201 tubes based upon the Columbia University GB3 and RPB8 design for the Signal Corps Engineering Laboratories and two of these tubes, numbers 63 and 33 were obtained by the Office of Naval Research for these propagation studies. These two were received by the University of Texas on April 20, 1954.

Because the magnetrons were classified confidential, no description has been given of them in the reports of the propagation tests.

This memorandum is for the purpose of giving a description of our installation and use of the Bomac magnetrons.

II. PROPAGATION TESTS

The tests in which the 4.3 millimeter magnetrons have been used are as follows:

A. Measurements were made over a 1000 foot path at random times over a period of two weeks for the purpose of determining the accuracy with which the level of signal strength could be measured. This level was found to be ± 0.2 db. These measurements also served to provide a reference signal level to which measurements over longer paths could be compared.

B. Distance runs up to 1000 feet were also made for the purpose of calibrating a reference attenuator. These measurements made use of the inverse square relationships of power attenuation.

C. Propagation characteristics were measured over a 3.5-mile line-of-sight path from the University Tower in Austin to the site of the KTBC-TV antenna tower and were sampled for 5 minute intervals on ten days.

D. Propagation data over a 7.0-mile line-of-sight path from the University Tower to the Balcones Research Center were taken for 5 minute intervals on sixteen days. These, and the previous measurements, are described in EERL Report No. 73 [1].

E. Propagation measurements in a very low level surface duct were made over a path length of seven miles near the coast of Bolivar Peninsula on the Texas Gulf Coast. Transmitter heights of 6, 10 and 15 feet mean sea level were used along with receiver heights of 4, 8 and 12 feet mean sea level. These tests will be described in Report 74.

III. MAGNETRON CHARACTERISTICS

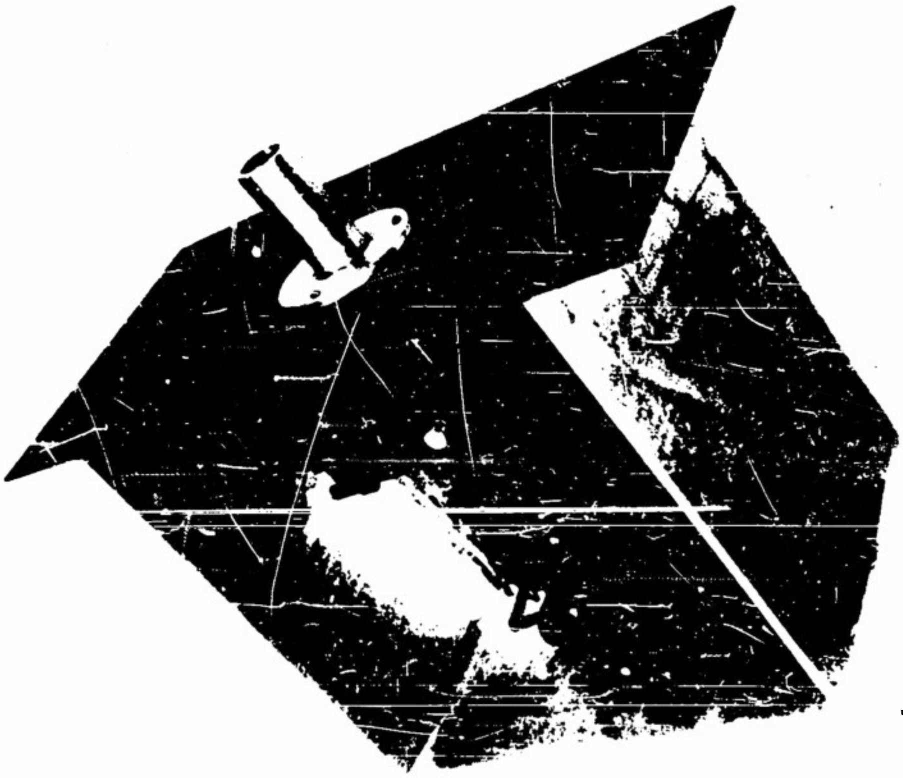
The type BL 201 magnetrons made by Bomac Laboratories were based on a design by Columbia University. This magnetron is of the rising sun type with an indirectly heated cathode. The magnetic field is of the order of 15,000 gauss.

The operating characteristics as specified by the Signal Corps are as follows:

	Tube No. 33	Tube No. 63
Heater Voltage (V)	6.0	5.0
Frequency (AMCS)	69.46	70.08
Anode Voltage (KV)	12.0	13.0
Anode Current (Ma)	4.0	3.5
Average Power (W)	3.0	3.8
Peak Power (KW)	11.5	14.6

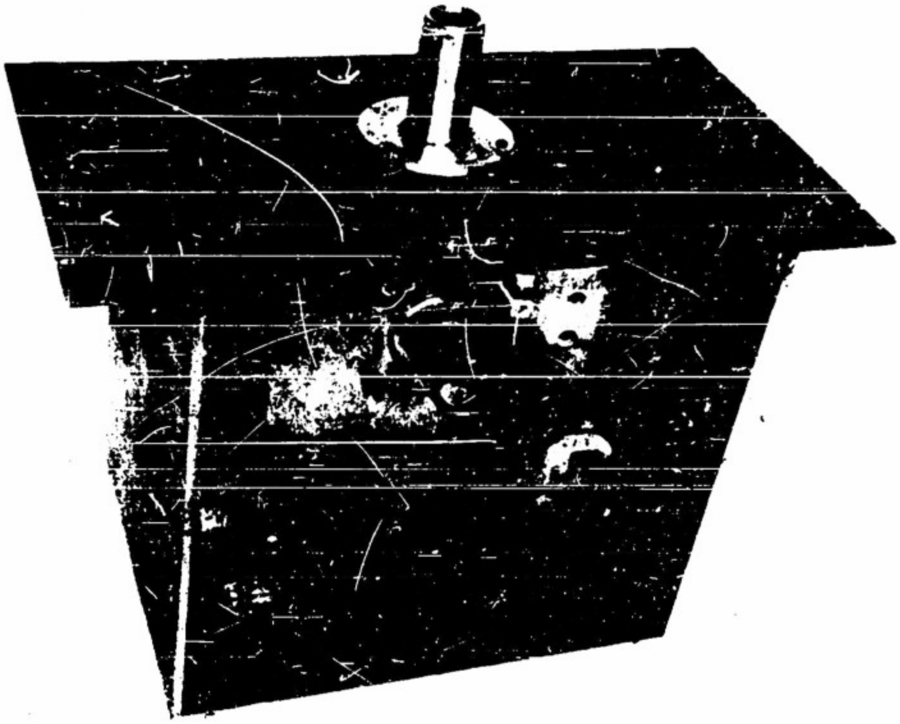
IV. INSTALLATION AND OPERATION OF MAGNETRONS

No operating instructions were included with the magnetrons, but on the basis of discussions with personnel of Bomac Laboratories magnetron no. 63 was mounted as shown in Figure 1.



TOP VIEW OF MAGNETRON MOUNTING

FIG. 1a



BOTTOM VIEW OF MAGNETRON MOUNTING

FIG. 1b

The magnetron was used in conjunction with a spark gap pulser producing a 0.25 microsecond pulse through a transformer with a turns ratio of one to eight. The pulse amplitude was adjustable from 8 to 15 kilovolts as measured across 1000 ohms. The filament of the cathode was heated with 6.3 volts for a period of approximately five minutes and the pulsing voltage was then applied and adjusted to produce an average magnetron current of 2.5 milliamperes. The filament voltage was then reduced to five volts which was the minimum value for which sustained oscillations could be maintained. An external spark gap was adjusted to prevent discharges within the magnetron.

The relative power output at 4.3 millimeter wavelength was noted as received by a crystal video receiver [1]. The character of the pulse was also observed with a sampler mounted at the lip of the horn antenna used at the transmitter and was found to be good. The magnetron and its pulser are shown in Figure 2.

The operating temperature of the cathode as seen through the waveguide coupling to the cavity was observed with an optical pyrometer and it was found that satisfactory operation of the magnetron was obtained with a temperature of approximately 870 degrees centigrade.

There was never any difficulty in starting the magnetron. On starting the power output would rise rapidly to a peak value and decrease approximately 2 db from this peak value in the first two minutes of operation. When the tube was functioning properly, the power output would then remain constant for at least thirty minutes.

V. PERFORMANCE OF TUBE NO. 63

Tube no. 63 was installed in the millimeter signal generator and the transmitting unit was installed in a small van truck. The generator was first used for the stability and calibration test described in section II, A and B.

After the magnetron had been used for about five hours with the truck in a number of different locations, it was found that it was necessary to operate the magnetron at a lower filament voltage in order to maintain the pulse length at 0.25 microseconds.

It was suggested by Mr. R. S. Briggs of Bomac Laboratories that the cathode be reactivated by operating the filament at 7.5 volts for a period of five or six hours. Even after this was done, however, there was no apparent improvement in the operating characteristics. Continued operation required still lower setting of the filament voltage to prevent a reduction in pulse length.

The filament voltage was found to be critical to the extent that a change of 0.1 volts at an operating voltage of approximately 3 volts would change the pulse length from 0.25 microseconds to something in the order of 0.05 microseconds. At the critical operating filament voltage crossing of the external filament leads would cause a change in operating characteristics which was the equivalent of a filament voltage change of 0.2 volts.

An attempt at recentering the cathode improved the operating characteristics to an extent that the filament could be operated at a higher voltage and a pulse length of 0.25 microseconds maintained.

MAGNETRON AND PULSER

FIG. 2

After about fifteen hours of calibration tests, measurements were started over the 3.5-mile path mentioned in section II-C. Reasonably satisfactory data were obtained for about five hours of operation of tube number 63 on this test.

After this the power output of the magnetron again began to fall off. Instead of becoming stabilized after a two minute warm-up period, there was a slow decline in power output of about 0.5 db for the next thirty minute interval. Since higher accuracy was required in the relative power stability for the propagation measurements, use of tube no. 63 was discontinued.

VI. PERFORMANCE OF TUBE NO. 33

Magnetron no. 33 was placed in operation and used for the remainder of the 3.5-mile test, for the 7.0-mile line-of-sight test and for the low level trapping tests.

The tube has now been operating satisfactorily for approximately thirty hours with little or no change in operating characteristics since first put into operation.

Each time the magnetron was started there was a power rise of approximately one decibel during the first two minutes of operation and a very stable power output for at least thirty minutes thereafter.

This tube was operated in the same way as magnetron no. 33 with the exception that each time the transmitter truck was moved, the magnetron panel was removed from the rack and packed in excelsior. It is felt that the elimination of shock and vibration encountered in transporting the magnetron in its truck mounted rack may have been partly responsible for the better performance of this tube.

VII. ACKNOWLEDGMENTS

Sponsorship of this work by the office of Naval Research and the assistance of Mr. M. C. Long of the Electronics Branch in obtaining the loan of the magnetrons is gratefully acknowledged.

The cooperation of the Signal Corps in making the magnetrons available for this work is also gratefully acknowledged.

Discussions with Mr. M. J. Bernstein of Columbia University and Mr. R. S. Briggs of Bomac Laboratories were very helpful and their cooperation is sincerely appreciated.

REFERENCES

1. Tolbert, C. W., Britt, C. O., Tipton, C. D., Straiton, A. W., "Propagation of 4.3-Millimeter Radio Waves on 3.5- And 7-Mile Paths," Electrical Engineering Research Laboratory, The University of Texas, 6 August 1954.

2. Tolbert, C. W., et al, "Trapping of Millimeter Radio Waves in Low Level Ocean Ducts," Electrical Engineering Research Laboratory, The University of Texas, to be prepared.

FIGURES

Addressee	Attention	No. of Copies
Engineering & Technical Division Office of the Chief Signal Officer Department of the Army Washington 25, D. C.	SIGOL-2 SIGET	1 1
Director of Research Signal Corps Engineering Laboratories Fort Monmouth, New Jersey		1
Commanding Officer Evans Signal Laboratory Belmar, New Jersey	SIGEL-RDB-3	2
Chief of Naval Research Department of the Navy Washington 25, D. C.	Code 427 460 416	3 1 1
Commander Wright Air Development Center Wright-Patterson Air Force Base, Ohio	Mr. Paul W. Springer WCIRD-2	1
Bell Telephone Laboratories Red Bank, New Jersey	Dr. H. T. Friis	1
Columbia Radiation Laboratory Columbia University 538 W. 120th St. New York 27, New York		3
Bomac Laboratories Beverly, Mass.	Mr. R. S. Briggs	3